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Introduction

Although artificial insemination is widely used in dairy cattle, it has found only limited application in beef cattle. Use of bulls in natural mating programs accounts for over 90% of the pregnancies achieved each year in the U.S. beef cattle industry, and a large percentage of the beef bulls used for natural mating are purchased as yearlings. Many of these yearling bulls undergo a breeding soundness examination prior to sale or the breeding season. This involves visual and manual examination of the genital system as well as assessment of semen, which is usually collected by electroejaculation. However, sex drive and mating ability, which are essential for the delivery of viable spermatozoa and impregnation of females, are not commonly measured.

Among beef bulls used for single-sire mating, large ranges in pregnancy rates have been reported, and only low correlations were found between pregnancy rates and semen characteristics. These differences may be potentially explained by differences in the levels of serving capacity (SC) between bulls. Several procedures for testing SC have been used; however, studies investigating the relationship between bulls' SC and herd fertility are inconclusive, with some researchers finding no relationship and other researchers reporting SC test results to be a good predictor of bull fertility. These studies differed in testing procedures used for measuring SC. Thus, differences in the findings may lie in the procedures used for tests or may be due to differences in bull-to-female ratios used when measuring fertility.

At present, there is a lack of research relating the SC of yearling beef bulls in a standardized test with their behavior and fertility under pasture mating conditions. The first objective of this study was to evaluate the sexual and grazing behavior of low and high SC yearling bulls when placed with naturally cycling and estrus synchronized cows under pasture mating conditions during both daylight and dark hours. The second objective was to determine the effect bull SC has on herd fertility, bull body temperature, and distance traveled under these conditions.

Procedure

Eighty crossbred (¼ Angus, ¼ Hereford, ¼ Pinzgauer, ¼ Red Poll) yearling (12-13 mo) beef bulls were subjected to three successive 30 min SC tests. For each test, four estrus-induced ovariectomized heifers were restrained by headgates in a rectangular test pen (25 ft x 50 ft). Bulls were randomly allotted into subgroups of five, and each subgroup was allowed to observe mating activity in the adjacent test pen for 30 min immediately prior to testing. The five prestimulated bulls were then placed in the test pen, and mounts and services were recorded by three independent observers. One week following the last SC test, bulls underwent a standard breeding soundness examination on two successive days. Based on results from these tests and other measurements, 20 bulls were selected that were similar in body wt, scrotal circumference, and seminal traits, but differed in SC. The 10 high SC (HSC) and 10 low SC (LSC) bulls averaged 5.6 and .7 services per test, respectively.

For pasture breeding, the experiment was designed so that each bull's behavior and fertility could be evaluated single-sire. The design was based on a 4-day cycle which was repeated 10 times and evaluated a different pair of HSC and LSC bulls during each cycle (Table 1). Total duration of the experiment was 40 days and began June 16, 1986. To determine mating activity of the bulls, daily observations (Table 1) were made from a centrally located tower (Fig. 1) using telescopes which allowed both daytime and nighttime viewing. In each cycle, bulls were first exposed to 25 naturally cycling cows per bull (average mating load) for three days beginning at 9 a.m. on day 1. These cows were removed at 8 a.m. on day 4 and replaced with 9 estrus synchronized cows for one day (heavy mating load). The heavy mating load was comparable to a bull to cow ratio of 1:175 when 5% of the cows in the herd are in estrus per day.

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Table 1—Design of low *vs* high serving capacity single-sire pasture mating experiment

Day of Cycle[a]	Daily observation schedule[b]	Total time in pasture per bull	No. of cows per pasture[c]	Mating load and status of cows
Days 1-3	6 a.m.-8 a.m. and 7 p.m.-9 p.m.	72 hr	25[d]	Average; Naturally cyclic cows (random estrus)
Day 4	9 a.m.-9 p.m.	24 hr	8.8[e]	Heavy; Synchronized cows (all in estrus)

[a]The design was based on a 4-day cycle which was repeated 10 times (cycle A-J). Total duration of experiment was 40 days and began on June 16, 1986.
[b]During cycles D, F, H, and J, animals were observed for 24 hr continuously on days 2 and 4. On day 1, when new block began, animals were observed from 9 a.m. to 11 a.m. rather than 6 a.m. to 8 a.m.
[c]For each cycle, two identical patterns (one with a LSC bull and one with a HSC bull) were used.
[d]The same 50 naturally cycling cows (25 per pasture) were used for cycles A-E (20 days), after which time they were replaced with 50 new cows for the remaining five cycles.
[e]Represents an average across all cycles.

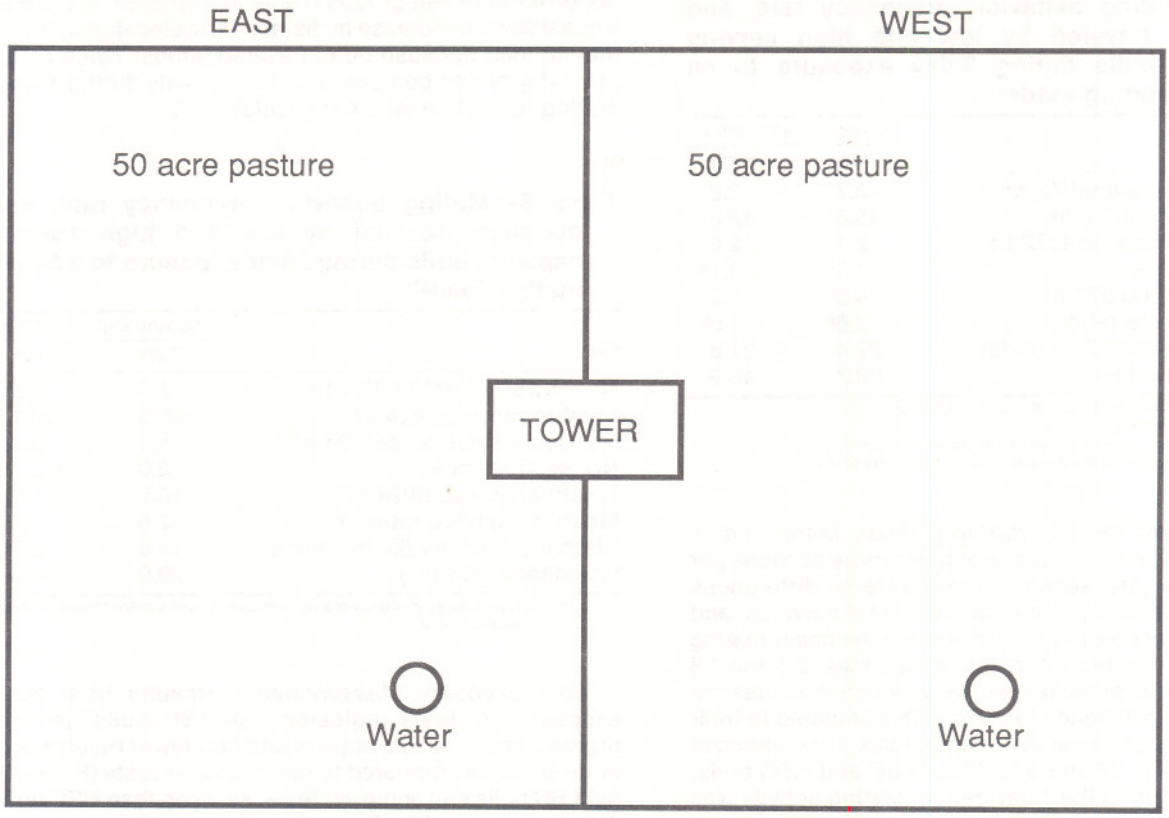

Figure 1—Diagram of identical 50-acre brome pastures where low *vs* high serving capacity single-sire mating experiment was conducted.

On the morning of the first day of each cycle, the pair of bulls to be evaluated were fitted with vibracorders, body temperature recording modules, and pedometers to monitor grazing time, body temperature, and distance traveled, respectively. After a short acclimation period (30 min to 1 hr), this equipment did not appear to affect the bulls' normal behavior. In early August, 10 days after completion of the last cycle, all 20 bulls underwent three post-exposure SC tests, followed 2 days later by breeding soundness examinations conducted in the same manner as those done pre-exposure.

Results

Behavior and Fertility During an Average Mating Load. During each 4-day period, each LSC and HSC bull was exposed to a similar number of cows in standing heat per bull (Table 2). HSC bulls had significantly more total services than LSC bulls, but number of total mounts tended to be higher for LSC bulls (Table 2). Mount-to-service ratio for LSC *vs* HSC bulls was 3.6 and 1.5, respectively ($P < .05$), which indicates that HSC bulls were more efficient when mating, although neither group bred all cows in standing heat. The range in services per cow was 0-4 for LSC and 0-8 for HSC bulls, and the number of services per cow was significantly higher for HSC bulls. During dark hours, there was surprisingly little sexual activity by either group of bulls. Except for a 1- to 2-hr grazing period that occurred around midnight, most of the herd spent the majority of the dark hours lying or standing. During the daylight hours, most cow-cow and bull-cow mounting activity occurred between 6 a.m. to 11 a.m. and 6 p.m. to 9 p.m.

Pregnancy rate did not differ significantly between SC groups during exposure to average mating load for 3 days (Table 2). Distance traveled was not different between SC groups (Table 2) and averaged 7.4 miles/24 hr/bull, which is considerable given the small size of the pasture (50 acres). During each 24-hr period under an avg mating load, LSC and HSC bulls grazed 7.8 (32.6%) and 9.0 hr (37.5%), respectively, which tended ($P = .12$) to indicate that LSC bulls spent less time grazing, and this may be related to the lower mating efficiency of LSC bulls. LSC bulls appeared to spend more time in courtship behavior with cows in heat than did HSC bulls. Body temperature did not differ between SC groups and averaged 102.7°F over each 24-hr period.

Table 2—Mating behavior, pregnancy rate, and distance traveled by low and high serving capacity bulls during 3-day exposure to an average mating load[ab]

Item	Serving capacity group	
	Low	High
No. cows in heat/bull/72 hr	3.7	3.8
Total mounts/bull/72 hr	15.6	12.0
No. cows serviced/bull/72 hr	2.1	2.6
No. services/cow	1.5[c]	3.1[d]
Total services/bull/72 hr	4.3[e]	8.2[f]
Mount-to-service ratio	3.6[e]	1.5[f]
Distance traveled/72 hr (miles)	22.4	21.8
Pregnancy rate (%)	58.3	48.9

[a]Each bull exposed to 25 naturally cyclic cows for 72 hr.
[b]Least-squares means.
[cd]Means within a row with different superscripts differ (P = .07).
[ef]Means within a row with different superscripts differ (P < .05).

Behavior and Fertility during a Heavy Mating Load. Although HSC bulls tended to achieve more services per cow and more total services, there were no differences between SC groups in total mounts, total services, and avg services per cow during exposure to the heavy mating load (Table 3). The mount-to-service ratio was 2.5 and 1.8 for LSC and HSC bulls, respectively, which indicates improved mating efficiency for LSC bulls compared to their efficiency (3.6) under an avg mating load. Total services ranged from 5 to 29 and 3 to 43 for LSC and HSC bulls, respectively, during the 1-day period. Mating activity was continual throughout the day despite occasional air temperatures as high as 100°F. Again, sexual activity during hours of darkness was practically nonexistent. Overall, pregnancy rates were low and did not differ between SC groups (Table 3). A possible explanation for low pregnancy rates is that synchronized cows were sorted prior to and immediately after bull exposure, and stress associated with this may have impaired conception or increased embryonic mortality.

There was no difference between bull SC groups for grazing time or body temperature, and the combined avg was 8.3 hr (36%) and 102.9°F, respectively. The increased sexual activity by bulls during exposure to synchronized cows did not result in a decrease in grazing time per 24-hr period (8.4 hr during avg mating load *vs* 8.3 hr during heavy mating load). Distance traveled did not differ between groups (Table 3). However, there was a considerable increase in distance traveled during heavy mating load because bulls traveled almost twice as far in a 1-day period compared to their activity during an avg mating load (13.6 *vs* 7.4 miles/day/bull).

Table 3—Mating behavior, pregnancy rate, and distance traveled by low and high serving capacity bulls during 24-hr exposure to a heavy mating load[ab]

Item	Serving capacity group	
	Low	High
No. cows in heat/bull/24 hr	8.8	8.8
Total mounts/bull/24 hr	39.5	39.1
No. cows serviced/bull/24 hr	5.1	5.7
No. services/cow	3.0	3.7
Total services/bull/24 hr	15.6	21.5
Mount-to-service ratio	2.5	1.8
Distance travelled/24 hr (miles)	14.6	12.6
Pregnancy rate (%)	29.0	34.8

[a]Each bull exposured to approximately nine estrus synchronized cows for 24 hr.
[b]Least-squares means.

Post Exposure Measurements. Results from post-exposure SC tests indicated that LSC bulls had improved in their sexual activity and had fewer mounts and more services compared to pre-exposure tests (P < .001), but LSC bulls still achieved fewer services than HSC bulls (3.2 *vs* 4.4, P = .06). Even though this difference was significant, LSC bulls' behavior indicated that they were not as low in SC as previously thought based on pre-exposure tests. This increase in the SC of LSC bulls was probably due to the sexual experience provided by the 4-day exposure to cows. Consistent with our findings, more recent research has found that some LSC yearling bulls showed a dramatic increase in their SC after exposure to short-duration sexual experience. Our observations indicated that LSC bulls appeared to be learning while exposed to an average mating load and had become more proficient when exposed to a heavy mating load as evidenced by a lower mount-to-service ratio. Results from this study suggest that LSC yearling bulls should be offered sexual experience and then retested before their inherent SC is determined.